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Supervisory support for subordinates' use of information and communication technologies: development and preliminary validation of a scale in a Chinese context

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The pervasive use of information and communication technology (ICT) for work comes at a considerable cost to well-being. This study focuses on the critical role of supervisors and introduces the concept of supervisory ICT support, a construct designed to capture the supervisory dimension of ICT interventions aimed at enhancing employee well-being. Through a four-phase procedure, we developed and validated a scale to measure supervisory ICT support. Based on 38 items generated from literature reviews and in-depth interviews, we conducted two surveys and applied exploratory ($n = 206$) and confirmatory factor analysis ($n = 560$) to identify the factor structure, resulting in two 4-item subscales: ICT consideration and ICT updating. To assess criterion validity, we conducted a two-wave survey ($n = 387$), which also enabled stronger causal inferences. The findings show that supervisory ICT support is a multidimensional construct, with two subdimensions—ICT consideration and ICT updating—and that it is positively related to employees' ICT control, perceived control of time, sense of learning, and sense of vitality. This research is the first to conceptualize and measure the supervisor's role in providing ICT-specific support to mitigate the negative effects of work-related ICT use on employees' well-being. It extends the leadership literature on technostress coping and offers a reliable and valid scale for measuring supervisory ICT support. Organizations are encouraged to position supervisors at the center of ICT interventions and equip them with the necessary skills to consider employees' emotional responses to ICT use. This study has practical implications for enhancing employee well-being in digital work environments by fostering supervisor-driven ICT support.

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Introduction

The ubiquitous use of information and communication technology (ICT), including mobile devices, internet services, and artificial intelligence at work, has been shown to enhance productivity while simultaneously imposing significant costs to employee well-being (Hu, Barber, et al., 2021). As ICT continues to play an increasingly critical role in reshaping work environments, its people-related implications have been recognized as having profound effects on work dynamics (Society for Industrial and Organizational Psychology, 2023). This impact is expected to grow due to various ICT-related stressors, such as techno-overload, techno-complexity, constant availability requirements, and lack of ICT control (e.g., Dettmers, 2017; Khan, 2023; Tarafdar et al., 2007). Such stressors have been linked to job burnout (e.g., Day et al., 2012), reduced job satisfaction (e.g., Ragu-Nathan et al., 2008), and elevated cortisol awakening response (e.g., Dettmers et al., 2016). Given that employee well-being is not only vital to individuals but also to organizational performance (Van De Voorde et al., 2012; Taris and Schreurs, 2009), organizations have devised effective interventions for enhancing employees' well-being in digital work contexts (e.g., Day et al., 2012; Ragu-Nathan et al., 2008).

At least two fields of study have examined well-being in ICT-enabled work environments. First, industrial-organizational psychology (I-O) has contributed influential research, such as Day et al. (2012), which found that supportive ICT practices in organizations, including the use of up-to-date technology and provision of prompt technical support, help reduce burnout. Additionally, effective training protocols have been shown to enhance employee well-being (Orfei et al., 2023). Second, information systems (IS) research has emphasized mitigating ICT-related stressors through technological advancements. Organizations can mitigate employee technostress by improving their information systems (Yin et al., 2018) or by introducing "positive" ICT solutions (Brivio et al., 2018). These solutions involves improved structure, augmentation, and simulation of ICT to foster positive functioning in individuals (Riva et al., 2012). Furthermore, technical support, learning facilitatation, and encouragement of technical involvement help counteract the negative effects of ICT-related stressors (e.g., Nisafani et al., 2020; Ragu-Nathan et al., 2008).

Despite the contributions in these fields, which often overlap, we identified a research gap that remains unaddressed. Most existing interventions focus on organizational-level efforts, neglecting the pivotal role of supervisors, who should "be at the center of organizational interventions" (Stich et al., 2018, pp. 103). This oversight is particularly notable given that supervisors typically exert a stronger influence on employees' technology experiences at work compared to many other factors (Waller and Ragsdell, 2012). While supervisors should take a more active role in mitigating the negative effects of ICT use at work, the specific influence of supervisors on ICT remains unclear and warrants further investigation (Fieseler et al., 2014). The closest construct to our interest, digital leadership, broadly encompasses leadership in digital environments, emphasizing the capabilities needed to facilitate and sustain digital transformation in organizations (Tigre et al., 2024) rather than focusing on employee well-being. These objectives may not always align, rendering the construct both overly broad and misaligned with interventions aimed at enhancing individual well-being. To address this gap, we propose a new construct—supervisory ICT support—defined as the behaviors supervisors exhibit to enhance employees' well-being through guidance and support in ICT use.

Building on this notion, our research aims to: (a) integrate the segmented research streams on ICT-related issues and their implications for well-being across I-O psychology, IS, and beyond (see e.g., Hu, Barber, et al., 2021; Hu, Park, et al., 2021), with a specific focus on the role of supervisors; (b) develop a reliable scale to measure supervisory ICT support, drawing on established measures such as those used to assess organizational ICT support (Day et al., 2012), technostress inhibitors (Ragu-Nathan et al., 2008); and (c) examine whether supervisory ICT support influences employee well-being, in terms of both ICT-specific and general occupational health, thereby facilitating cross-disciplinary validation of the proposed construct.

The current research contributes to the ICT intervention research in three ways. First, it consolidates the previously segmented lines of research on ICT-driven issues affecting workers' experience (Hu, Barber, et al., 2021; Hu, Park, et al., 2021). Second, it advances the field by highlighting the critical role of supervisors in providing ICT-specific support to enhance employee well-being, offering empirical evidence that supervisors are pivotal to effective ICT interventions in digital work environments. Third, by drawing on data from China, it extends knowledge to emerging economies, where many workers experience higher levels of technostress (Lauterbach et al., 2023). In addition to offering further insights into theoretical perspectives on interventions, we also provide practical recommendations for organizations to design more effective strategies that safeguard employee well-being amid rapid ICT advancements.

Phase 1: Item generation and reduction

In Phase 1, we developed the initial pool of items for measuring supervisory ICT support. Given that few, if any, directly applicable supervisory ICT support instruments have been published, we combined deductive and inductive methods (Hinkin, 1998) to generate items for our scale. First, we conducted a literature review on ICT interventions. Particularly, we used research on organizational ICT support (Day et al., 2012), technostress inhibitors (Ragu-Nathan et al., 2008), positive ICT events (Braukmann et al., 2018), information system design (Tarafdar et al., 2019), and practitioner-oriented work on ICT interventions (e.g., Stich et al., 2018). If similar items at the organizational level were available, we rewrote them by replacing organizational with "supervisor" items, following research on other general supervisor support (e.g., Eisenberger et al., 2010). Through this procedure, we obtained 24 items.

Second, we conducted in-depth interviews with 30 full-time workers to obtain new insights. Our interviewees were recruited among those who use a variety of ICT for work purposes. They came from multiple types of organizations in mainland China, including private enterprises (56.67%), state-owned businesses (16.67%), foreign-invested companies (16.67%), and government agencies or public institutions (10.00%). Amongst these interviewees, six (20.00%) held managerial or supervisory roles. The interviewees were young, on average 26.40 ($SD = 6.36$) years old, and their average total tenure and organizational tenure was 4.55 years ($SD = 6.09$) and 2.54 years ($SD = 5.32$), respectively. Interviewees held jobs in various professional fields, including human resource management, marketing and sales, engineering, general management, IT, website editing, education consulting, teaching, accounting and finance, and customer service. After providing a general working definition of supervisory ICT support to the interviewees, we asked them to describe behaviors that direct supervisors could display to help them cope with the negative ICT experiences at work. Through these interviews, 172 items were written.

Third, we conducted a systematic category analysis on these 196 (24 + 172) items in Chinese, following Nunnally and Bemstein's (1994) procedure. To balance the inclusivity and

recognized relevance of the items in the pool, three native Chinese-speaking authors (average age = 45.67, $SD = 8.01$; one female; all with at least 15 years of experience in organizational behavior and human resource management research) followed the practices in similar studies (e.g., De Gooyert et al., 2022; Zhu et al., 2019) to ensured that: (a) only behaviors that were mentioned at least three times were included; (b) each item clearly described a specific behavior; and (c) similar items were combined into one. After removing ambiguous, redundant items, or those outside the scope of our conceptualization of supervisory ICT support (Hinkin, 1998; Nunnally and Bemstein, 1994), 39 items were retained. To ensure face validity, we then consulted five HR managers (average age = 36.00, $SD = 1.41$; three females; all with at least 5 years of experience in human resource management) affiliated with a part-time MBA program at a public university in mainland China to evaluate each item. While the consulted HR managers agreed that all items assess the extent of guidance and support provided by supervisors to their subordinates in the use of ICT, one reverse-coded item (i.e., "My supervisor prohibits me from using any information technology to handle work tasks") was removed from the pool due to its inapplicability in the workplace. Thus, a total of 38 items were retained.

Fourth, we employed the people-centered and task-centered leadership framework to preliminarily classify the items. These two leadership styles are often conceptualized as distinct dimensions: relationship-oriented (consideration) and task-oriented (initiating structure), as established by the Ohio State Leadership Studies (see e.g., Fleishman, 1953; Stogdill and Coons, 1957). This framework has received broad support in leadership and supervision research (see e.g., Blake and Mouton, 1964; Derue et al., 2011; Lin et al., 2025; Smith, 1991). As an initial step, we assigned 19 items to each dimension. Five native Chinese-speaking experts in organizational behavior and industrial-organizational psychology (average age = 39.20, $SD = 3.43$; two females; all holding PhDs and with at least 5 years of research experience) were invited to assess whether each item accurately reflects its assigned dimension, using a seven-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The results showed that the average ratings for all items were at least 4.00, except for three reverse-coded items, which received average ratings of 1.00. The agreement rates among the five researchers were ~53 and 57%, with Kappa values of 0.71 and 0.66 for the two dimensions, respectively. Given the small sample size of raters, the interrater reliability is considered moderate (McHugh, 2012). Based on these findings, all 38 items were retained for the next phase of the study.

Phase 2: Factor identification and measurement construction

Methods (Phase 2)

Participants and procedures (Phase 2). To obtain a diverse sample, we used non-probability purposive convenience sampling technique to recruit participants. First, four undergraduate students working on a university-funded training project for undergraduate students served as a survey team supervised by the first author. With the help of these students, we recruited 258 full-time white-collar workers who needed to use ICT for work purposes among their family members, friends, and acquaintances. After screening for low-quality data, 52 responses were eliminated because of short response time, invariant responding, or low personal reliability (DeSimone et al., 2015). Thus, the final sample included 206 participants.

Of these participants, 55.34% were male, and 90.29% had a bachelor's degree or higher. The participants came from multiple types of organizations in mainland China, including private enterprises (49.51%), foreign-invested companies (19.42%), state-owned businesses (16.99%), and government and public institutions (14.08%). The average age and organizational tenure of these participants were 31.90 ($SD = 6.98$) and 8.82 years ($SD = 6.74$), respectively. They had been working with their current supervisors for 3.83 years ($SD = 2.61$) on average.

Measure (Phase 2). Participants responded to questions about demographic characteristics, and filled out the preliminary 38-item supervisory ICT support scale. All items were rated on a seven-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Higher scores reflected stronger supervisory ICT support.

Statistical strategies (Phase 2). We used the freeware tool RStudio 2022.07.1 (Posit team, 2024) in the R (version 4.1.0) environment for data analysis, using the R package "*psych*" (Revelle, 2024). First, we conducted an item analysis to determine which item had item discrimination indices greater than 0.30 (Hair et al., 2018). After dropping items that had inadequate discrimination, we conducted a series of exploratory factor analysis (EFA) to identify the factor structure of supervisory ICT support. Specifically, we employed a common factor analysis method to identify the underlying dimensions represented in the common variance of the retained items (Hair et al., 2018). When the supervisory ICT support scale was established through a series of EFA procedures, we examined the internal consistency reliability of the retained items in the scale.

Results (Phase 2)

EFA. Before conducting EFA, the item analysis showed that 36 of the initial 38 items had adequate discrimination. The sampling adequacy (MSA) test using Kaiser-Meyer-Olkin measure (overall MSA = 0.94) and the Bartlett test for sphericity ($\chi^2_{(630)} = 5350$, $p < 0.001$) indicated that the remaining 36 items were suitable for EFA (Hair et al., 2018). Parallel analysis suggested two factors should be retained with the first two Eigenvalues (17.68, 1.22) exceeding those generated from random simulated data (1.00, 0.81). This two-factor solution was also identified by using other stopping rules such as the latent root criterion and scree test (Hair et al., 2018). Specifically, only the first two Eigenvalues generated from the observed data were greater than 1. The scree plot showed that the Eigenvalues for all potential factors did not change sharply compared to their precedent, except for the first two. Based on the results above, we retained two factors.

In the next step, we conducted a maximum likelihood factor analysis with an oblique rotation (direct oblimin) using the system default value of delta, allowing the extracted factors to be correlated (Hair et al., 2018). To ensure at least one-half of the variance of each item was explained and had adequate explanation, eight items with communalities greater than 0.50 were retained (Hair et al., 2018). The standardized factor loadings for each item on their intended factors ranged from 0.60 to 0.83, while cross-loadings on non-target factors ranged from −0.07 to 0.19. Building on the widely recognized people-centered and task-centered leadership framework, we labeled the two extracted factors as ICT Consideration and ICT Updating based on the content of the four items loading onto each factor. The factor "ICT consideration" reflects how a supervisor mitigates the adverse ICT experiences of employees at work. It captures people-centered (i.e., consideration) management practices (Fleishman, 1953), and accounted for 29.38% of the variance in the eight items. The factor "ICT updating" reflects how a supervisor facilitates the use of up-to-date ICT at work, capturing task-centered (i.e., initiating structure) management practices (Fleishman, 1953). It accounted for 28.38% of the variance in

Table 1 Factor loadings for the exploratory factor analysis.

Item	Factor		Communality
	ICT consideration	ICT updating	
1. My supervisor prompts the organization to introduce the latest IT equipment or tools.	−0.04	0.73	0.50
2. My supervisor prompts the organization to implement appropriate software as it becomes available.	0.18	0.60	0.55
3. My supervisor helps me get the technology upgrades that I need.	0.14	0.68	0.62
4. My supervisor facilitates the timely implementation of new information technology systems in my work.	−0.07	0.83	0.61
5. My supervisor asks the technical support people to respond promptly to any of my problems.	0.71	0.07	0.58
6. My supervisor cares about my feelings in the face of information demands at work.	0.60	0.19	0.57
7. My supervisor actively responds to my dissatisfaction with the information office system.	0.76	−0.05	0.53
8. My supervisor tries to alleviate my burden of electronic statements/reports.	0.83	−0.03	0.64
Eigenvalue	2.35	2.27	
Percentage of variance explained	29.38	28.38	
Cumulative percentage of variance explained	29.38	57.76	

Since the present study validated a Chinese version of the instrument, the English items presented in this table are for information purposes only.

the eight items. Although the cumulative percentage of variance explained by these two factors (i.e., 57.76%) did not exceed the common threshold of 60% (Hinkin, 1998), the actual amount of variance accounted for by meaningful factors may be lower in some instances (Hair et al., 2018). Furthermore, the two-factor structure of our EFA model provided a good fit to the data ($\chi^2_{(13)} = 14.68$, CFI = 1.00, TLI = 1.00, RMSEA (90% CI) = 0.03 (0.00, 0.08), RMR = 0.02) (Hair et al., 2018). Given these results, the two-factor solution (see Table 1) was deemed to be adequate.

Further examination of the multidimensionality of the scales was needed because the two factors strongly correlated with each other ($r = 0.73$, $p < 0.001$). To verify whether the variance of the eight items could be explained by a single factor, we conducted another EFA while forcing the extraction of one factor. For the current sample, all eight items loaded at least 0.64 on a single factor. However, fit indices ($\chi^2_{(20)} = 79.94$, CFI = 0.92, TLI = 0.89, RMSEA (90% CI) = 0.12 (0.09, 0.15), RMR = 0.07) indicated that this single-factor solution did not fit well to the data (Hair et al., 2018). Given that previous research has found a strong correlation between the people-centered (i.e., consideration) and task-centered (i.e., initiating structure) dimensions of leader behavior, ranging from −0.57 to 0.74 (e.g., Bledsoe and Brown, 1977; Weissenberg and Kavanagh, 1972), it seems worthwhile to view the two factors identified in supervisory ICT support (i.e., ICT consideration and ICT updating) as distinct yet interrelated dimensions.

Next, we conducted an EFA to examine whether the shared variance across the two factors could be represented by a higher order factor. We found that ICT consideration and ICT updating loaded 0.85 on the higher order factor that we labeled as the overall supervisory ICT support. It accounted for 72.50% of the variance of its two subordinate factors. Drawing on Johnson et al.'s (2011) work, we concluded that supervisory ICT support can be conceptualized as a superordinate multidimensional construct, captured by two subdimensions.

Reliability analysis. We used Cronbach's α coefficient to determine the internal consistency reliability of the retained items of the supervisory ICT support scale. Analyses showed that (a) the Cronbach's α coefficient for the overall scale was 0.89; (b) the Cronbach's α coefficient for the ICT consideration and ICT updating subscales were both 0.84. All the Cronbach's α coefficients were greater than the commonly accepted cutoff values of 0.70 (Hinkin, 1998). Thus, the internal consistency of the remaining eight items (see Table 1) was adequate.

Table 2 Mean, *SD*, reliability if an item is dropped, and item-total correlations.

Item	Mean	SD	Cronbach's α if an item is dropped	item-total correlations
sis1	5.40	1.20	0.88	0.59
sis2	5.40	1.20	0.87	0.68
sis3	5.30	1.20	0.87	0.71
sis4	5.30	1.20	0.88	0.64
sis5	5.10	1.20	0.87	0.68
sis6	5.00	1.20	0.87	0.70
sis7	4.80	1.20	0.88	0.61
sis8	4.80	1.40	0.87	0.68

The combination of sis and the following numbers refers to the 8 measurement items of supervisory ICT support in Table 1.

To further evaluate the performance of individual items, we also conducted item analysis on the remaining eight items. Results (see Table 2) showed that all items received positive ratings on a seven-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*), with Means exceeding 4.80. Additionally, the Cronbach's α coefficient (i.e., 0.89) for the overall scale was higher than for any subscale with an item dropped, suggesting that no item should be excluded. The item-total correlations ranged from 0.59 to 0.71, indicating that all items were well aligned with the construct of supervisory ICT support.

Phase 3: Construct validity

Methods (Phase 3)

Participants and procedures (Phase 3). The same strategy as for Phase 2 was used to obtain an independent sample. Four graduate students, who were working with the first author on a project funded by the Natural Science Foundation of China, served as an independent survey team and recruited another 573 full-time white-collar workers from their family members, friends, and acquaintances to complete our survey. 13 responses were eliminated because of short response time, invariant responding, or low personal reliability (DeSimone et al., 2015). Thus, the final sample included 560 participants.

Amongst these participants, 43.21% were male, and 94.29% had completed college-level education or higher. The average age and working years of these participants were 26.20 ($SD = 5.79$) and 4.30 ($SD = 5.50$), respectively.

Table 3 Fit indices for both proposed and alternative models.

Model	$\chi^2_{(df)}$	$\Delta\chi^2_{(df)}$	CFI	TLI	RMSEA (90% CI)	SRMR
Second-order model	46.05 $_{(19)}$		0.99	0.99	0.05 (0.03, 0.07)	0.02
Two-factor correlated model	46.05 $_{(19)}$	0.00 $_{(0)}$	0.99	0.99	0.05 (0.03, 0.07)	0.02
One-factor model	93.44 $_{(20)}$	47.39 $_{(1)}$ ***	0.98	0.97	0.08 (0.07, 0.10)	0.03

$n = 560$. The marker method was used to test the second-order model of supervisory ICT support. For the identification of this second-order model, the loadings of the two first-order factors were constrained to be equal, and the variance of the second-order factor was freely estimated.
***$p < 0.001$.

Measures (Phase 3). In addition to the demographic characteristics, participants were administered the two measures described below. They were rated using a seven-point Likert scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

Supervisory ICT support. Supervisory ICT support was measured with the eight items we retained through the EFA procedure in phase 2 (see Table 1). Cronbach's α coefficient for this scale was 0.93. Cronbach's α coefficients for its two dimensions, namely, ICT consideration and ICT updating, were 0.89 and 0.88.

Organizational ICT support. Organizational ICT support was assessed with Day et al.'s (2012) two-dimensional eight-item scale. Originally developed in English, the scale was translated into Chinese by three native Chinese-speaking authors with advanced proficiency in English. These bilingual authors hold PhDs in organizational behavior and human resource management and possess extensive experience in translating psychological instruments. Following the established guidelines for cross-cultural adaptation of psychological measures (e.g., Brislin, 1970), two bilingual authors independently translated the instruments and then reconciled any discrepancies through discussion. The final version was reviewed by a third bilingual author to ensure sematic equivalence. Sample items included "My organization uses the latest technology" and "Our information technology support staff are helpful". Cronbach's α coefficient for this scale was 0.87. Cronbach's α coefficients for its two dimensions were 0.81 (*ICT resources/Upgrades*) and 0.89 (*ICT personal assistance*).

Statistical strategies (Phase 3). We employed a Maximum Likelihood estimation to conduct a series of confirmatory factor analyses (CFA) using the R package "*lavaan*" (Rosseel, 2012) with the freeware tool RStudio 2022.07.1 (Posit team, 2024) in the R (version 4.1.0) environment. Given the small sample size in this phase, the following criteria for the fit indices were used to evaluate the CFA models: $\chi^2/df < 5$, both CFI and TLI ≥ 0.90, RMSEA ≤ 0.08, and the SRMR ≤ 0.06 (Hair et al., 2018). Next, we computed the composite reliability (CR) and the average variance extracted (AVE) values to evaluate the construct validity of supervisory ICT support. The threshold values for CR and AVE used in this study were 0.50 and 0.60, respectively (Hair et al., 2018).

Results (Phase 3)

CFA. Taking the second-order multidimensional model as the baseline, we conducted three CFAs to examine the factor structure of supervisory ICT support. Fit indices for these models are presented in Table 3.

As shown in Table 3, the baseline model had a good fit to the data: $\chi^2_{(19)} = 46.05$, CFI = 0.99, TLI = 0.99, RMSEA (90% CI) = 0.05 (0.03, 0.07), SRMR = 0.02 (Hair et al., 2018). Although the first-order two-factor correlated model fit the data ($\chi^2_{(19)} = 46.05$, CFI = 0.99, TLI = 0.99, RMSEA (90% CI) = 0.05 (0.03, 0.07), SRMR = 0.02) equally well as the baseline model, a second-order model is usually preferable if it fits the data (Hair et al., 2018). Furthermore, Table 3 show that the single-factor model also had a good fit to the data: $\chi^2_{(20)} = 93.44$, CFI = 0.98, TLI = 0.97, RMSEA (90% CI) = 0.08 (0.07, 0.10), SRMR = 0.03 (Hair et al., 2018). However, its fit indices decreased by 0.01 or more, and the Chi-square value increased significantly ($\Delta\chi^2_{(1)} = 47.39$, $p < 0.001$). These results demonstrated the distinctiveness of the two subdimensions of supervisory ICT support (Hair et al., 2018). Thus, we concluded that supervisory ICT support is a superordinate multidimensional construct.

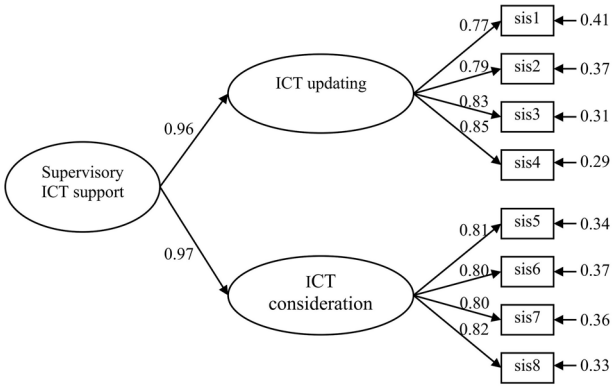

Fig. 1 Completely standardized estimates for the second-order model of supervisory ICT support. sis is the abbreviation for supervisory ICT support.

According to the CFA for the second-order factor model using the marker method (see Fig. 1), each item loaded on the intended first-order factor significantly at the 0.001 level, ranging from 0.77 to 0.85. The loadings of the two first-order factors, namely, ICT updating and ICT consideration, on the second-order factor were 0.96 ($p < 0.001$) and 0.97 ($p < 0.001$), respectively.

Convergent validity. To examine the convergent validity of our second-order multidimensional model of supervisory ICT support, CR and AVE values were computed. Based on the standardized loadings (see Fig. 1), our calculation found that the CR for the second-order factor (i.e., supervisory ICT support) was 0.96, and for its two subdimensions, namely, ICT updating and ICT consideration were both 0.88. In addition, the AVE values for supervisory ICT support, ICT updating, and ICT consideration were 0.93, 0.66, and 0.65, respectively. Both CR and AVE values were greater than the conventional threshold values (Hair et al., 2018). These results support the convergent validity of supervisory ICT support as a superordinate multidimensional construct.

Discriminant validity. We included both supervisory ICT support and Day et al.'s (2012) organizational ICT support in our CFA model to test the discriminant validity of supervisory ICT support. We argued that the scales would be correlated but statistically distinguishable, as supervisory ICT support represents a narrower construct than organizational ICT support, and with

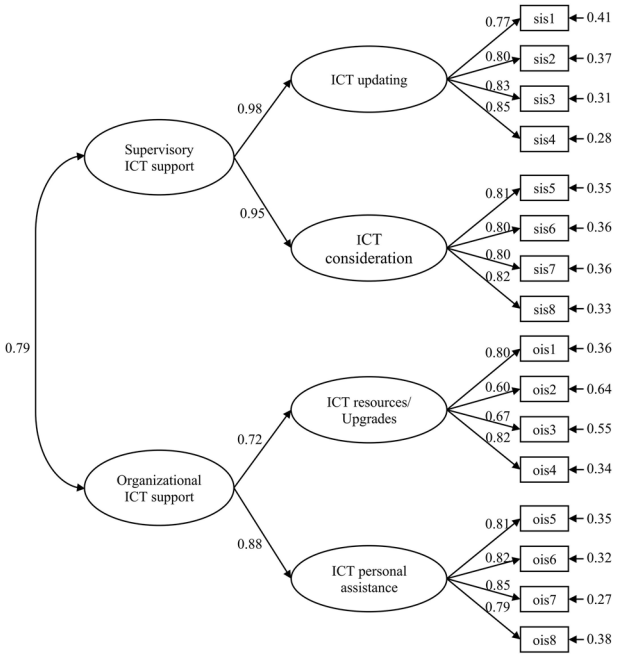

Fig. 2 Completely standardized estimates for the second-order model of supervisory ICT support in relation to organizational ICT support. sis is the abbreviation for supervisory ICT support; ois is the abbreviation for organizational ICT support.

different support sources (supervisor *vs* organization). Specifically, we modeled both supervisory ICT support and organizational ICT support as second-order constructs. The proposed model with these two second-order constructs exhibited a good fit to the data: $\chi^2_{(99)} = 284.96$, CFI = 0.97, TLI = 0.96, RMSEA (90% CI) = 0.06 (0.05, 0.07), SRMR = 0.04 (Hair et al., 2018). As expected, organizational ICT support and supervisory ICT support correlated significantly ($r = 0.79$, $p < 0.001$) (see Fig. 2).

To establish the distinctiveness of the two scales, we merged them into one second-order factor including the four first-order factors (i.e., ICT updating, ICT consideration, ICT resources/upgrades, and ICT personal assistance). This model also has an acceptable fit ($\chi^2_{(100)} = 337.75$, CFI = 0.96, TLI = 0.95, RMSEA (90% CI) = 0.07 (0.06, 0.07), SRMR = 0.06) to the data (Hair et al., 2018). However, the Chi-square value increased significantly ($\Delta\chi^2_{(1)} = 52.79$, $p < 0.001$), and most fit indices except for RMSEA decreased by 0.01 in comparison to the proposed model with two second-order constructs. Besides, the AVE values for supervisory ICT support and organizational ICT support in our proposed model were 0.93 $[(0.98^2 + 0.95^2)/2]$ and 0.65 $[(0.72^2 + 0.88^2)/2]$, respectively. Both of these AVE values were greater than the conventional threshold values of 0.50 (Hair et al., 2018), and above the squared correlation between supervisory ICT support and organizational ICT support of 0.62 (0.79×0.79). According to the Fornell-Larcker criterion (Fornell and Larcker, 1981), we concluded that our eight-item scale of supervisory ICT support was distinguishable from Day et al.'s (2012) organizational ICT support scale.

Phase 4: Criterion validity

In this phase, we incorporated ICT control, perceived control of time, sense of learning, and sense of vitality as criterion variables. ICT control can be viewed as an ICT-specific construct, and perceived control of time was included to assess possible consequences of frequent ICT interruptions or constant availability requirements (Hu, Barber, et al., 2021; Hu, Park, et al., 2021). The sense of learning and vitality are two established subconstructs of a relatively general occupational health construct, namely, thriving at work (Porath et al., 2012; Spreitzer et al., 2005). As such, we examined constructs close to ICT-related consequences in experiencing control, and how certain aspects of thriving at work may be affected.

Supervisory ICT support and ICT Control. ICT control denotes the perception of the degree of control an individual has over how to use and/or choose technology at work. Low ICT control was found to be associated with certain individual outcomes, such as increased ICT stress, strain, and burnout (e.g., Day et al., 2010, 2012). As one of the important components for the perceived ICT demands (Day et al., 2012), the lack of ICT control might induce potential or even actual loss of an individual's mastery over the way, the type, and where one uses ICT for work purposes. Given that mastery has long been operationalized as an example of personal characteristics which constitute resources (Hobfoll et al., 2018), low ICT control might trigger a loss spiral. Drawing on the conservation of resources (COR) theory (Hobfoll et al., 2018), the resource loss associated with low ICT control would hamper an individual from thriving in a stressful working environment. But similar to organizational ICT support (Day et al., 2012), supervisory ICT support can also serve as a job resource that assists employees in today's digital working environment. Following the COR theory's corollary 1, stronger supervisory ICT support may offer employees augmented job resources. Consequently, this increased resource availability may render employees less vulnerable to resource loss (Hobfoll et al., 2018), thereby fostering a strengthened mastery experience concerning the way, the type, and where one uses ICT for work purposes. Therefore, we expect that supervisory ICT support might help employees gain more robust ICT control. This leads to the following hypothesis:

Hypothesis 1: Supervisory ICT support is positively related to employees' ICT control.

Supervisory ICT support and perceived control of time. Perceived control of time delineates an individual's feeling of being in control of one's time (Macan, 1994). This feeling related to mastery can be operationalized as a job resource according to COR theory (Hobfoll et al., 2018). We focus on this outcome given that individuals with greater resources are usually less vulnerable to resource loss and more capable of resource gain (Hobfoll et al., 2018). One's perceived control of time may be impaired as a variety of synchronous (e.g., instant messengers) and asynchronous (e.g., e-mail) communication technologies have been used for work purposes. For example, employees tend to feel the need to respond quickly to each incoming e-mail even though it is usually not necessary to be dealt with immediately (Barber and Santuzzi, 2015). In addition, work-related ICT use on mobile devices is blurring the boundaries between work and life domains, which creates extended and/or constant availability requirements for employees (Day et al., 2012; Dettmers et al., 2016). Messages via ICT can come in any time, and employees who rely on it for work-related communications might experience a loss of control over their time. However, supervisory ICT support can equip employees with more resources and buffer the adverse effects mentioned above (Hobfoll et al., 2018). As such, we argue that supervisory ICT support might facilitate employees' perceived control of time. This leads to the following hypothesis:

Hypothesis 2: Supervisory ICT support is positively related to employees' perceived control of time.

Supervisory ICT support and sense of learning. Sense of learning is one of the essential components of thriving at work, capturing the sense of acquiring greater knowledge and skills (Spreitzer et al., 2005). We included it as a criterion because it is closely related to individual excellence (Spreitzer et al., 2005), and employees need to adapt to today's rapidly changing ICT work context. Specifically, previous researches have shown that certain characteristics of ICT, namely techno-complexity and techno-uncertainty, can create heavy learning demands on employees to constant update their ICT-related knowledge and skills (e.g., Day et al., 2012; Tarafdar et al., 2007). Otherwise, employees may not be able to properly use ICT for performing their job duties. However, supervisory ICT support should help under this circumstance. Drawing on the COR theory, a stronger supervisory ICT support might offer employees with greater job resources, which in turn facilitate employees to cope with the ICT-related learning demands at work (Hobfoll et al., 2018). As such, employees would be more likely to have a desirable subjective experience in terms of learning that helps them navigate and change the ICT work context. Based on the arguments above, we contend that supervisory ICT support can be expected to promote the sense of learning experienced by employees in today's digital working environment. This leads to the following hypothesis:

Hypothesis 3: Supervisory ICT support is positively related to employees' sense of learning.

Supervisory ICT support and sense of vitality. Sense of vitality is also an essential component of thriving at work. It captures the positive feeling of being energetic and alive (Spreitzer et al., 2005). This positive feeling has a close connection with the more general construct well-being. Given that both scholars and practitioners used to call for designing possible ICT-related interventions to boosting employee well-being (e.g., Hu, Barber, et al., 2021; Stich et al., 2018), including sense of vitality as a criterion variable of the current study is straightforward. Comparing to the common ICT demands and/or technostress creators (e.g., techno-overload, constant availability requirements), supervisory ICT support can be categorized as a specific ICT intervention that helps to alleviate the negative effect of work-related ICT use on employees. By displaying stronger ICT-related support, supervisors might offer employees with greater job resources to cope with the ICT demands and/or technostress creators at work (Hobfoll et al., 2018). Similar evidence has been found for the contributor role that resources play to promote individual well-being (Hobfoll et al., 2018). For example, O'Driscoll et al. (2010) identified training and support for ICT users as two critical organizational-level factors that enhance employees' well-being in the digital working environment. Day et al. (2012) found that organizational ICT support was associated with lower level of employee strain, exhaustion, and cynicism. Based on the arguments above, we expect that supervisory ICT support may help in promoting employees' sense of vitality. This leads to the following hypothesis:

Hypothesis 4: Supervisory ICT support is positively related to employees' sense of vitality.

Methods (Phase 4)

Participants and Procedure (Phase 4). All participants were full-time white-collar workers in the information and technology service industry. They were recruited through Credamo, an online survey platform similar to Prolific, commonly used in China. Given its trustworthy data collection services, more and more research (e.g., Ma and Li, 2024; Zhou et al., 2024) has been using Credamo to conduct survey and experiment in recent years. To mitigate the problem of common method bias (CMB), we followed Podsakoff et al.'s (2024) recommendations and conducted a two-wave survey to introduce temporal separation between the measurement of the independent variables in Wave 1 and criterion variables in Wave 2, with an interval of ~2 weeks between the two waves.

Each participant received an incentive of 10 RMB (~1.38 USD) for providing complete and valid responses in our two-wave survey. And responses were retained only when participants completed both waves, and 400 matched responses were received. After dropping low-quality data by following DeSimone et al.'s (2015) procedure, 387 responses were retained for analysis. Amongst these participants, 54.26% were female, and 95.09% had completed college-level education or higher. The average age and total working years of these participants were 34.14 ($SD = 3.54$) and 10.13 years ($SD = 3.94$), respectively. The participants were predominantly from private enterprises (71.83%) and state-owned businesses (18.09%), with ~10.08% employed by foreign-invested or mixed-ownership companies.

Measures (Phase 4). The measures used in this phase, originally published in English, were translated into Chinese following the same procedure as in Phase 3 before being presented to participants. To strengthen causal inference and reduce potential CMB, we employed a temporal separation strategy by measuring supervisory ICT support in Wave 1 and the criterion variables (i.e., ICT control, perceived control of time, sense of learning, and sense of vitality) in Wave 2.

Supervisory ICT support (Wave 1). Supervisory ICT support was rated by participants on the eight-item scale we developed ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). Sample items included "My supervisor helps me get the technology upgrades that I need" and "My supervisor cares about my feelings in the face of information demands at work". Cronbach's α for this measure was 0.86.

ICT control (Wave 2). ICT control was assessed with the three-item subscale adapted from Day et al.'s (2012) perceived ICT demands measure. Participants were asked to indicate the frequency to which they experienced the decision authority over ICT using a six-point Likert scale ranging from 1 (*never*) to 6 (*always*). A sample item was "I have control over how I use technology at work". Cronbach's α for this measure was 0.71.

Perceived control of time (Wave 2). Perceived control of time was assessed with four reversed coding items adapted from Macan' (1994) work. Participants were asked to indicate the extent to which they can affect how their time is spent using a seven-point Likert scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). A sample items was "I find it difficult to keep to my schedule because others take me away from my work". Cronbach's α for this measure was 0.73.

Sense of learning and vitality (Wave 2). Sense of learning and vitality were measured with the thriving at work scale developed by Porath et al. (2012) using a seven-point Likert scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). In this scale, five items assessed sense of learning, and five items assessed sense of vitality. The Chinese version of this scale has been validated in previous study (e.g., Zhu et al., 2024). Sample items for these two dimensions were "I find myself learning often" and "I feel alive and vital", respectively. Cronbach's α was 0.89 for the thriving at work scale as a whole. And the Cronbach's α for the sense of learning and the sense of vitality subscales were 0.76 and 0.84, respectively.

Table 4 Means, standard deviations, and correlations among the study variables.

Variables	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1. Gender[a]	0.54	0.50	1.00										
2. Education level[b]	2.23	0.53	0.16**	1.00									
3. Working years	10.13	3.94	−0.10*	−0.25***	1.00								
4. Social desirability	5.54	0.87	0.02	−0.03	−0.09†	1.00							
5. ICT familiarity	5.91	0.68	−0.09	0.10*	−0.10†	0.29***	1.00						
6. Transformational leadership	5.85	0.84	0.16**	0.01	−0.09†	0.48***	0.39***	1.00					
7. Supervisory ICT support	5.59	0.79	0.08	0.05	−0.17***	0.44***	0.50***	0.80***	1.00				
8. ICT control	4.60	0.79	−0.00	0.06	−0.15**	0.34***	0.33***	0.45***	0.51***	1.00			
9. Perceived control of time	3.17	0.64	0.11*	0.03	−0.15**	0.46***	0.30***	0.51***	0.49***	0.49***	1.00		
10. Sense of learning	6.17	0.63	0.17**	0.02	−0.07	0.30***	0.33***	0.65***	0.58***	0.33***	0.37***	1.00	
11. Sense of vitality	5.73	0.90	0.06	0.01	−0.12*	0.45***	0.45***	0.70***	0.66***	0.53***	0.68***	0.60***	1.00

$n = 387$.
[a]Gender was coded as 0 for male, and 1 for female.
[b]Education level was coded as 1 for some college education or lower, 2 for undergraduate level education, 3 for graduate-level education.
$^{\dagger}p < 0.10$ (two-tailed), $^{*}p < 0.05$ (two-tailed), $^{**}p < 0.01$ (two-tailed), $^{***}p < 0.001$ (two-tailed).

Control variables (Wave 1). Following recent recommendations regarding the selection of control variables(Sturman et al., 2022), we included control variables based on their theoretical relevance and potential to confound the effects of supervisory ICT support on the four criterion variables. This approach enabled us to avoid a purely mechanical inclusion of control variables and instead ground our choices in established conceptual arguments and prior empirical research.

First, we controlled for ICT familiarity, as individuals with greater ICT knowledge may better cope with ICT-related demands (e.g., Nouri et al., 2022). Four items adapted from Dong et al.'s (2024) AI familiarity scale were used to assess participants' familiarity with ICT on a seven-point Likert scale, ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). A sample item was "I know a lot about ICT". Cronbach's α for this measure was 0.75.

Second, we included transformational leadership to account for its conceptual overlap with supervisor behaviors (Bass, 1990). It has commonly been controlled for in previous research when establishing the validity of new leadership and/or supervision constructs and measures (e.g., Zhu et al., 2019). Participants were instructed to respond to Carless et al.'(2000) seven-item short measure of transformational leadership using a seven-point Likert scale, ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). The Chinese version of this scale has been validated in previous study (e.g., Lin, 2023). A sample item was "My supervisor communicates a clear and positive vision of the future". Cronbach's α for this measure was 0.89.

Third, we controlled for social desirability to mitigate bias in self-reported responses (Arthur et al., 2021) and to facilitates the testing for potential CMB using the directly measured latent variable technique (Podsakoff et al., 2024). Drawing on Tan et al.'s (2022) research, we asked the participants to respond to five items adapted from Crowne and Marlowe (1960) using a seven-point Likert scale, ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*). A sample item was "No matter who I'm talking to, I'm always a good listener". Cronbach's α for this measure was 0.75.

Fourth, we also controlled for several individual characteristics usually found to have a close association with individual well-being (e.g., Ariño-Mateo et al., 2024; Day et al., 2012; Kleine et al., 2019). Specifically, gender, measured as a dichotomous variable coded as 0 for male and 1 for female; educational level, coded as 1 for some college education or lower, 2 for undergraduate level education, 3 for graduate-level education; and tenure, the number of years working.

Statistical strategies (Phase 4). We used the R package "*psych*" (Revelle, 2024) to assess the internal consistency reliability for each measure, and to conduct the descriptive statistics and Pearson correlation analysis. Then, we conducted a series of CFAs using the R package "*lavaan*" (Rosseel, 2012) to assess the latent factor structure of our measurement model, as well as the potential CMB. To test our hypotheses, we conducted a series of hierarchical linear regressions using the R package "*stats*" developed by the R Core Team (2024) and contributors worldwide. All analyses were conducted using the freeware tool RStudio 2022.07.1 (Posit team, 2024) in the R (version 4.1.0) environment.

Results (Phase 4)

Confirmatory factor analysis for the measurement model. We conducted a series of CFAs to examine the goodness-of-fit for our measurement model, which comprised eight latent constructs: social desirability, ICT familiarity, supervisory ICT support, transformational leadership, ICT control, perceived control of time, sense of learning, and sense of vitality. Given the small sample size, we employed item parceling for each subdimension of supervisory ICT support before constructing the measurement model (Bandalos and Finney, 2001). The overall fit indices ($\chi^2_{(566)} = 879.62$, CFI = 0.95, TLI = 0.94, RMSEA (90% CI) = 0.04 (0.03, 0.04), SRMR = 0.04) supported our measurement model well, outperforming all alternative models with fewer factors. Thus, our measurement model had a good fit to the data (Hair et al., 2018).

Although we separated independent and criterion variables over time, we cannot rule out CMB because all the measures were collected from one source. Drawing on Podsakoff et al.'s (2024) work, we applied the directly measured latent variable technique and tested for CMB, modeling all items loading onto social desirability. Even though this model exhibited a good fit to the data ($\chi^2_{(543)} = 866.78$, CFI = 0.95, TLI = 0.94, RMSEA (90% CI) = 0.04 (0.03, 0.04), SRMR = 0.06) (Hair et al., 2018), its fit indices did not surpass those of the measurement model ($\Delta\chi^2 = 12.84$, $\Delta df = 23$, $p = 0.96$). Furthermore, the average variance explained by the directly measured latent variable (i.e., social desirability) for items measuring other constructs was 0.15, falling far below the commonly suggested 0.50 cutoff for the presence of a substantial common factor (Hair et al., 2018). Therefore, CMB was considered not to be a problem.

Descriptive statistics. Means, standard deviations, and correlations are presented in Table 4. Results show that supervisory ICT

Table 5 Regression analyses of supervisory ICT support on employees' ICT control, perceived control of time, sense of learning, and sense of vitality.

	ICT control		Perceive control of time		Sense of learning		Sense of vitality	
	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2
Gender[a]	−0.06	−0.05	0.05	0.05	0.08*	0.08*	−0.02	−0.01
Education level[b]	0.03	0.02	−0.01	−0.01	−0.01	−0.01	−0.03	−0.03
Working years	−0.09†	−0.06	−0.08†	−0.07	0.00	0.01	−0.04	−0.02
Social desirability	0.13*	0.11*	0.26***	0.26***	−0.03	−0.03	0.11**	0.10**
ICT familiarity	0.15**	0.09†	0.09*	0.06	0.11*	0.08†	0.19***	0.15***
Transformational leadership	0.33***	0.11	0.33***	0.22**	0.60***	0.51***	0.58***	0.45***
Supervisory ICT support		0.32***		0.15*		0.14*		0.17**
F	22.01***	22.07***	31.48**	27.80***	48.61***	42.56***	75.11***	66.73
R^2	0.26	0.29	0.33	0.34	0.43	0.44	0.54	0.55
ΔR^2		0.03***		0.01*		0.01*		0.01**

$n = 387$. Standardized regression coefficients were reported.
[a]Gender was coded as 0 for male, and 1 for female.
[b]Education level was coded as 1 for some college education or lower, 2 for undergraduate level education, 3 for graduate-level education.
$^{\dagger}p < 0.10$ (two-tailed), $^{*}p < 0.05$ (two-tailed), $^{**}p < 0.01$ (two-tailed), $^{***}p < 0.001$ (two-tailed).

support was positively related to ICT control ($r = 0.51$, $p < 0.001$), perceived control of time ($r = 0.49$, $p < 0.01$), sense of learning ($r = 0.58$, $p < 0.001$), and sense of vitality ($r = 0.66$, $p < 0.001$), respectively. These correlations provide preliminary support for the criterion validity of supervisory ICT support. Table 4 further illustrates that individuals with higher social desirability or ICT familiarity tended to provide more positive responses overall. Additionally, the table reveals a strong effect of transformational leadership, suggesting that individuals responded more positively when supported by transformational leadership.

Hypotheses testing. Taking the four criterion variables (i.e., ICT control, perceived control of time, sense of learning, and sense of vitality) as outcomes, we conducted a series of two-step regression analyses to examine the criterion validity of supervisory ICT support.

As can be seen in Table 5, supervisory ICT support had a positive association with employees' ICT control ($\beta = 0.32$, $p < 0.01$), perceived control of time ($\beta = 0.15$, $p < 0.05$), sense of learning ($\beta = 0.14$, $p < 0.05$), and sense of vitality ($\beta = 0.17$, $p < 0.01$), respectively. Taking in to account the control variables, supervisory ICT support accounted for a significant increase in explained variance in ICT control ($\Delta R^2 = 0.03$, $p < 0.001$), perceived control of time ($\Delta R^2 = 0.01$, $p < 0.05$), sense of learning ($\Delta R^2 = 0.01$, $p < 0.05$), and sense of vitality ($\Delta R^2 = 0.01$, $p < 0.01$). These results further support Hypothesis 1, 2, 3, and 4, which stated that Supervisory ICT support is positively related to employees' ICT control, perceived control of time, sense of learning, and sense of vitality. Thus, we concluded that the criterion validity of supervisory ICT support is adequate.

Supplementary analysis. First, we conducted multicollinearity diagnostic protocol due to the high correlation between transformational leadership and supervisory ICT support was high ($r = 0.80$, $p < 0.001$; see Table 4). Variance inflation factors (VIFs) for all predictors (including controls) in our criterion-validity regressions were found to range from 1.10 to 3.16, falling below the conventional cutoff of 10 (Hair et al., 2018) and the more conservative threshold of 5 (O'Brien, 2007). Recent methodological critiques (e.g., Kalnins and Hill, 2025), however, have highlighted these widely used VIF cutoffs are overly permissive and may overlook problematic levels of multicollinearity. We therefore re-estimated each model after excluding transformational leadership that exhibited the highest VIF (3.16). And the direction and significance of supervisory ICT support effects remained stable (see Appendix A), indicating that multicollinearity did not severely bias our findings (Kalnins and Hill, 2025).

Second, we reran the regression analyses after excluding social desirability to assess whether the positive effects of supervisory ICT support on the criteria were confounded by potential CMB bias (Podsakoff et al., 2024). The results (see Appendix B) indicated that supervisory ICT support still had positive associations with employees' ICT control ($\beta = 0.33$, $p < 0.001$), perceived control of time ($\beta = 0.17$, $p < 0.05$), sense of learning ($\beta = 0.13$, $p < 0.10$), and sense of vitality ($\beta = 0.18$, $p < 0.01$). These findings indicated that all our hypothesized positive relationships between supervisory ICT support and each of the four criteria were not confounded by the potential CMB concerns stemming from social desirability.

Third, we further examined the effects of the two dimensions of supervisory ICT support—ICT consideration and ICT updating—on each of our criterion variables. When these moderately correlated ($r = 0.66$, $p < 0.001$) dimensions entered simultaneously, ICT consideration uniquely had positive associations with employees' ICT control ($\beta = 0.25$, $p < 0.001$), perceived control of time ($\beta = 0.13$, $p < 0.05$), and sense of vitality ($\beta = 0.20$, $p < 0.001$), while ICT updating uniquely had a positive association with employees' sense of learning ($\beta = 0.24$, $p < 0.001$; see Appendix C). Since VIFs in these models peaked at 3.36 for transformational leadership, we re-estimated each model after excluding this variable to mitigate potential redundancy following the recommendations of Kalnins and Hill (2025). Without serious multicollinearity bias concerns—VIFs peaked at 2.02 for ICT updating exhibit—all statistically significant regression coefficients for both ICT consideration and ICT updating in these new models exhibit the expected positive signs (see Appendix D). Importantly, the pattern of the effects ICT consideration has on the four criterion variables held no matter transformational leadership was included or excluded (see Appendix C and Appendix D), suggesting that the people-centered dimension—ICT consideration—may serve a more important role in supervisory ICT support. Moreover, the effects of ICT consideration and ICT updating remained consistent even after excluding social desirability (see Appendix E).

Taken together, these supplementary analyses demonstrated that (1) multicollinearity did not severely bias our findings, (2) CMB did not confound the effects of supervisory ICT support,

and (3) while both subdimensions of supervisory ICT support contributed uniquely to different outcomes, the people-centered dimension—ICT consideration—may play a more pivotal role in general.

Discussion

Following Hinkin's (1998) procedure, we developed and validated an eight-item scale for measuring supervisory ICT support. Results show that supervisory ICT support is multidimensional, encompassing two subdimensions, namely, ICT consideration and ICT updating. In addition, the hypothesized criterion validity of supervisory ICT support was confirmed in an assessment where the scale and criteria were measured at different time points. It was positively related to ICT control, perceived control of time, sense of learning, and sense of vitality at work, respectively, while controlling for gender, education level, working years, social desirability, ICT familiarity, and transformational leadership.

Theoretical implications. The present research contributes valuable knowledge to ICT interventions aiming to boost employee well-being in digital work settings in three ways. First, the present research highlights the crucial role supervisors play in facilitating employees' well-being in digital work contexts. Compared to organizational-level ICT interventions, such as organizational ICT support (Day et al., 2012), technostress inhibitors(Ragu-Nathan et al., 2008), and similar efforts (e.g., Brivio et al., 2018; Tarafdar et al., 2019; Yin et al., 2018), this study is the first to address Stich et al.'s (2018) call for positioning supervisors at the center of ICT interventions. Although general leadership constructs like transformational leadership were found to foster employee well-being in the ICT-enabled environment, the supervisory ICT support we propose did offer significant incremental value in explaining employees' ICT control, perceived control of time, sense of learning, and sense of vitality at work. Interestingly, the positive association between transformational leadership and the ICT-specific construct, ICT control, became insignificant when supervisory ICT support was included (see Table 5). Nonetheless, transformational leadership continues to complement supervisory ICT support in enhancing other aspects of employee well-being, including perceived control of time, sense of learning, and sense of vitality. These findings suggest that supervisory ICT support, as an ICT-specific supervisor behavior, is particularly effective in improving employees' technology-related experiences rather than general work experiences.

Second, the present research developed and validated an eight-item scale for measuring supervisory ICT support, enabling future investigations into the consequences and antecedents of supervisory ICT support. This advancement underscores the critical role supervisors play in digital work environments. Given the particularly strong effectiveness of supervisory ICT support in enhancing employees' control over the ICT used at work (see Table 5), this study serves as a starting point for transforming the understanding of supervisory and leadership determinants of employees' ICT experiences. Beyond confirming the greater importance of supervisory support compared to other forms of support (e.g., Shi and Gordon, 2020) and individual characteristics like ICT familiarity, this research shifts the focus toward ICT-specific leadership behaviors, moving beyond broader constructs such as empowering leadership (Bauwens et al., 2021) and supervisor proactivity (Lin and Wang, 2022). Although the eight-item scale identified two dimensions of supervisory ICT support, the people-centered dimension—ICT consideration—emerged as more pivotal in enhancing employees' ICT experiences due to its inherent connection to employees' emotional well-being at work. This notion is further supported by supplementary analyses, which revealed that ICT consideration positively predicted three of the four outcome variables (i.e., ICT control, perceived control of time, sense of vitality), whereas ICT updating was only associated with employees' sense of learning.

Third, this research not only generated and adapted items from relevant studies on organizational ICT support (Day et al., 2012), technostress inhibitors (Ragu-Nathan et al., 2008), and similar work (e.g., Braukmann et al., 2018; Stich et al., 2018; Tarafdar et al., 2019), but also introduces both ICT-specific and general occupational health constructs to examine the criterion validity. This approach helps integrate previously fragmented ICT intervention research across different domains, addressing Hu, Barber, et al.'s (2021) call for consolidating ICT research within I-O psychology. As various ICT, particularly artificial intelligence, continue to reshape the working environment and interpersonal interactions (Einola and Khoreva, 2023; Mendy et al., 2024), supervisory ICT support, or its appropriate variations tailored to specific technological characteristics or contexts, may offer a promising framework for understanding how organizations design effective ICT interventions.

Practical implications. Our research also has at least three implications for practice. First, the two subdomains identified in supervisory ICT support should be considered. Supervisors need to demonstrate both people-centered and task-centered behaviors. People-centered behaviors, labeled as ICT consideration, involve alleviating employees' burden from electronic statements/reports and actively responding to employees' dissatisfaction with the information system. Task-centered behaviors, labeled as ICT updating, focus on facilitating the timely implementation of new technology in the workplace and proactively adopting the latest technologies. Although both subdomains of supervisory ICT support were found to positively influence certain well-being criteria, ICT consideration serves as the dominant facilitator, particularly when predicting ICT-specific well-being outcomes. Therefore, organizations should encourage managers to be more considerate of employees' feelings regarding ICT use at work.

Second, our findings have important implications for ICT-related training and development programs in organizations, beyond addressing the most recent technical issues. Organizations should design programs that help supervisors better understand the sentiments and challenges employees face when dealing with ICT demands. Given the greater importance of ICT consideration within supervisory ICT support, incorporating content that enhances supervisors' emotional intelligence is also beneficial. Specifically, such programs enable supervisors to better address employees' feelings toward using ICT for work. Additionally, these programs should ensure that supervisors are equipped to effectively understand and utilize the latest ICT tools for work purposes. This enables supervisors to appropriately provide ICT support and resources, helping potentially distressed employees recover and thrive at work.

Third, the additional explained variance of supervisory ICT support, after controlling for individual differences such as gender, education level, years of experience, social desirability, ICT familiarity, and the more general leadership construct of transformational leadership, in each of the four criterion variables suggests that supervisors can be positioned at the center of organizations' ICT interventions. Organizations should encourage supervisors to take responsibility for fostering employee well-being in the digital work environment. To this end, considering supervisory ICT support as one of the criteria in performance appraisals, rewards, and promotions could be beneficial.

Limitations and suggestions for future research. Our present research has several limitations. First, the scales we used in this study need further validation. Specifically, although we drew on relevant studies (e.g., organizational ICT support and technostress inhibitors) conducted in Western contexts, the validation of our newly developed scale for supervisory ICT support has certain limitations due to the regionally constrained sample in China. Importantly, this scale was validated in Chinese, and the English items presented in Table 1 are for information purposes only. Their psychometric properties have not been established in English-speaking populations, and the applicability of this scale is applicable in other cultural contexts remains uncertain. As legal and regulatory differences may exist regarding the work-related use of ICT (e.g., Eurofound and the International Labour Office, 2017), we suggest that future research focus on examining the cross-cultural applicability of this scale and update it over time in accordance with new ICT developments. Additionally, aside from our newly developed supervisory ICT support scale, the other instruments used in this study were originally developed and validated in English. Their Chinese translations have not undergone extensive psychometric validation, which may limit the generalizability of the findings in this study. We recommend future research conduct further validation of these scales in both Chinese and other cultural contexts to provide more valuable insights into the relevant topics.

Second, the outcome and control variables we included when examining the criterion validity of supervisory ICT support were limited. Future research should consider other ICT-specific and general constructs as criterion variables (e.g., telepressure, work engagement). Including supervisory or leadership constructs (e.g., digital leadership), which relate to ICT-driven issues but do not specifically incorporate support for employee well-being (Tigre et al., 2024), could deepen future analyses. Moreover, future research should explore the mechanism through which supervisory ICT support enhances employees' well-being by introducing mediators (e.g., ICT satisfaction, ICT enjoyment) and moderators (e.g., ICT self-efficacy, organizational ICT maturity). These should help move forward the ICT research as suggested by I-O psychologists (e.g., Hu, Barber, et al., 2021; Hu, Park, et al., 2021).

Third, there is room for improvement in the sampling and data collection of this study. Given that ICT-related issues are a key stressor for Chinese workers (Richardson and Antonello, 2022), who may experience technostress at higher levels compared to their counterparts in other emerging economies (Lauterbach et al., 2023), the small size of samples—primarily consisting of young professionals recruited through non-probability purposive sampling—may have introduced bias and limited the generalizability of our findings. Additionally, while the two-wave survey used to examine the criterion validity of supervisory ICT support reduces CMB by temporally separating the measurement of the predictor and criterion variables, its single-source design remains a limitation (Podsakoff et al., 2024). Future research should employ experimental or longitudinal designs with more representative samples to better establish causal relationships.

Conclusions

This research advances our understanding of supervisory ICT support by developing and validating an eight-item scale that captures two dimensions—ICT consideration and ICT updating—of supervisor behaviors that enhance employees' well-being through ICT guidance and support. It enriches the leadership and supervision literature on technostress coping and offers a valuable framework for organizations to design effective ICT interventions. The findings highlight the importance of positioning supervisors at the center of organizations' ICT interventions. Organizations are encouraged to equip managers with the skills necessary to address employees' feelings regarding the work-related use of ICT. Future research should examine the cross-cultural applicability of the scale, consolidate research across I-O psychology, IS, and other relevant fields by investigating the underlying mechanisms through which supervisory ICT support influences employee outcomes, and explore how emerging technologies (e.g., AI-driven tools) may reshape supervisory practices.

Data availability

Due to the sensitivity of participant data and confidentiality agreements, the datasets are not publicly available but may be obtained from the first author upon reasonable request.

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Author contributions

Juncheng Zhang: Conceptualization, Methodology, Investigation, Software, Writing—Original Draft, Writing—Reviewing & Editing, Supervision, Funding acquisition. Wendelien van Eerde: Writing—Original Draft, Writing—Reviewing & Editing. Fang Liu: Validation, Writing—Reviewing & Editing, Funding acquisition. Weiqi Chen: Formal analysis, Writing—Reviewing & Editing, Supervision. All authors have read and agreed to the published version of the manuscript.

Ethical approval

This study involving human participants was conducted in accordance with an approved research protocol (Protocol number: ECSM72071052) granted by the Ethics Committee of the School of Management, Guangzhou University, on 13 July 2020. The protocol encompasses a series of related studies under a broader research program led by the first author, with the present study constituting one such component. All procedures involving human participants were conducted in accordance with institutional and/or national ethical standards, as well as the tenets of the Declaration of Helsinki.

Informed consent

Written informed consent was obtained from all participants prior to data collection in this four-phase study. Specifically, interview participants received printed consent forms from the first author on October 7, 2021. In Phase 2 and Phase 3, survey participants received printed consent forms from two independent survey teams under the supervision of the first author, on May 3 and December 14, 2022, respectively. In Phase 4, participants received digital consent forms via the online survey platform Credamo (comparable to Prolific and commonly used in China), which we commissioned to conduct a two-wave survey starting on December 20, 2024. All participants were fully informed of the first author's identity, as well as the study's purpose, scope, methods, and possible risks. They were assured of anonymity and confidentiality, and were informed that their responses would be used only in aggregated form for academic publications and presentations. Participants also retained the right to withdraw from the study at any time, in which case their data securely destroyed upon request.

Competing interests

The authors declare no competing interests.

AI disclosure

The authors employed AI-assisted tools (e.g., ChatGPT, DeepSeek) for limited language polishing. All content was critically reviewed and finalized by the authors collectively.

Additional information

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